Site-Specific Sampling and Analysis Plan Addendum
Delineation of Soil Contamination Along the Sewer Lines Between TNT Area A and Waste Water Treatment Plant 1
Former Plum Brook Ordnance Works, Sandusky, Ohio

Prepared for:

Commander
U.S. Army Engineer District, Nashville
Post Office Box 1070
Nashville, Tennessee 37202-1070

Prepared by:

Shaw Environmental, Inc.
312 Directors Drive
Knoxville, Tennessee 37923

Shaw Project Number 139798

October 2010

Revision 0

Shaw® a world of Solutions™

312 Directors Drive
Knoxville, Tennessee 37923
865.690.3211
FAX: 865.690.3626

October 19, 2010

U.S. Army Engineer District, Nashville
ATTN: CELRN-EC-E (Ms. Kathy McClanahan)
110 Ninth Avenue South, Room 682
U.S. Court House Annex
Nashville, Tennessee 37203

Submittal of the Final Work Plan
Delineation of Soil Contamination Along the Sewer Lines
Between TNT Area A and Waste Water Treatment Plant 1
Former Plum Brook Ordnance Works, Sandusky, Ohio
Contract No. W912QR-08-D-0013: Shaw Project Number 139798

Dear Ms. McClanahan:

In accordance with the requirements of Delivery Order No. DX18 of Contract No. W912QR-08-D-0013 Shaw is pleased to submit this final Work Plan for Delineation of Soil Contamination Along The Sewer Line Between TNT Area A and Waste Water Treatment Plant 1 at the Former Plum Brook Ordnance Works (PBOW) located in Sandusky, Ohio.

Enclosed are four copies of this final work plan. Copies have also been sent to those on the distribution list as shown on the attached page. As requested, the document was sent to the Center of Expertise and the Restoration Advisory Board Co-Chair in electronic format only.

Should you have any questions or require additional information regarding this submittal, please do not hesitate to contact me at (865) 694-7496.

Sincerely,

Steven T. Downey, PE, PMP
Project Manager

Enclosures

Control Copy Distribution List

Name	Control Copy
U.S. Army Engineer District, Nashville ATTN: CELRN-EC-E (Ms. Kathy McClanahan) 110 Ninth Avenue South, Room 682 Annex Nashville, TN 37203	1-4
U.S. Army Engineer District, Huntington ATTN: CELRH-PM-PP-P (Mr. Rick Meadows) 502 Eighth Street Huntington, West Virginia 25701-2070	5-7 (CD provided)
Mr. Paul Jayko Site Coordinator Division of Emergency and Remedial Response (DERR) Ohio Environmental Protection Agency 347 North Dunbridge Road Bowling Green, Ohio 43402-0466	8, 9
Mr. Janusz Z. Byczkowski Division of Emergency and Remedial Response (DERR) Lazarus Government Center 1220 South Front Street Columbus, OH 43216-1049	10
Mr. Robert Lallier Environmental Coordinator NASA - Plum Brook Station 6100 Columbus Avenue Sandusky, Ohio 44870	11
U.S. Army Corps of Engineers (**electronic only**) HTRW Center of Expertise ATTN: CEHNC-CX-EG (Vern StJohn) 1616 Capitol Avenue Omaha, Nebraska 68144-3869	(CD provided)
Mr. John Blakeman (**electronic only**) PBOW RAB Co-chairman 2412 Scheid Road Huron, Ohio 44839	(CD provided)

Shaw® Shaw Environmental, Inc.

DISCIPLINE SIGN-OFF REVIEW

Client Name: U.S. Army Engineer District, Nashville; CELRN-EC-E

Project Description: Delineation Along the Sewer Lines Between TNTA and WWTP1
Former Plum Brook Ordnance Works, Sandusky, Ohio

Contract No. W912QR-08-D-0013 | Delivery Order No. DX18

Project No. 139798 | Task/Phase Number: 02000000

Document Type	Identify specific section or segment covered by this checkprint	Document Origin
☐ Technical / Cost Proposal		X Originator Developed
☐ RFP		☐ Edited Standard
☐ Contract / Subcontract		☐ Client Furnished
X Work Plans	Work Plan	
☐ Report		**Document Status**
☐ Risk Assessment / Evaluation		☐ Preliminary
☐ Specifications & Plans		☐ Internal Draft
☐ Design Calculations		☐ Draft
☐ Tables		☐ Draft Final
☐ Drawings / Figures		X Final
☐ Other:		☐ Other:

	Required Person	Signature	Date
Originator	Karl Van Keuren	[signature] for	10-19-10
Editor	Donald Groseclose	[signature]	10-19-10
Technical Review	Eric Weaver	[signature] for	10-19-10
Technical Review	Tom Siard	[signature]	10-19-10
Technical Review	Michael Gunderson	[signature] for	10-19-10
Env. Health & Safety	Doug Russell	[signature]	10-19-10
Quality Assurance Mgr	Ken Martinez	[signature]	10-19-10
Project Manager	Steven Downey	[signature]	10-19-10

NOTICE: By signature above, parties certify that the subject document has been prepared by and/or reviewed by them (as appropriate), that all review comments have been resolved, and that the document is ready for submittal.

Table of Contents

Page

Page

List of Tables

List of Figures

List of Acronyms

ASTM	American Society for Testing and Materials
DNT	dinitrotoluene
DOD	U.S. Department of Defense
DQO	data quality objective
EPA	U.S. Environmental Protection Agency
IDW	investigation-derived waste
mg/kg	milligrams per kilogram
NASA	National Aeronautics and Space Administration
PARCCS	precision, accuracy, representativeness, completeness, comparability, and sensitivity
PBOW	Plum Brook Ordnance Works
PPE	personal protective equipment
QAPP	quality assurance project plan
Shaw	Shaw Environmental, Inc.
SSAP	site-specific sampling and analysis plan
SWSAP	sitewide sampling and analysis plan
TNT	trinitrotoluene
TNTA	TNT Area A
USACE	U.S. Army Corps of Engineers
WWTP1	Waste Water Treatment Plant No. 1

1.0 Project Description

The U.S. Army is conducting studies of the environmental impact of suspected hazardous waste sites at previously owned U.S. Department of Defense (DOD) properties. One such site is the former Plum Brook Ordnance Works (PBOW), located in Sandusky, Erie County, Ohio (Figure 1-1). PBOW is being investigated under the Defense Environmental Restoration Program for Formerly Used Defense Sites. The investigation is being managed and technically overseen by the Nashville and Huntington Districts of the U.S. Army Corps of Engineers (USACE). The 9,000-acre PBOW facility was used for the manufacture of explosives during World War II and is currently owned by the National Aeronautics and Space Administration (NASA) and operated as the Plum Brook Station of the John Glenn Research Center at Lewis Field.

This site-specific sampling and analysis plan (SSAP) has been prepared by Shaw Environmental, Inc. (Shaw) for the fieldwork to be carried out to delineate soil contamination along the waste water sewer lines which extended from the former TNT Area A (TNTA) to the former Waste Water Treatment Plant No. 1 (WWTP1). This SSAP is an addendum to the sitewide sampling and analysis plan (SWSAP) (Shaw, 2008a) and was developed in accordance with the PBOW SWSAP (Shaw, 2008a) and the quality assurance project plan (QAPP) (Shaw, 2008b) to ensure that work performed at the subject site will be of the quality required to satisfy the overall and site-specific project objectives. A sitewide accident prevention/sitewide safety and health plan (Shaw, 2008c) was also prepared for this investigation to help provide a safe work environment.

1.1 PBOW Facility History

The PBOW site was built in early 1941 and manufactured 2,4,6- trinitrotoluene (TNT), dinitrotoluene (DNT), and pentolite. Production of explosives began in December 1941 and continued until 1945. After the plant was shut down, decontamination of TNT, acid, pentolite, and DNT processing lines began; decontamination was completed by the Army during the last quarter of 1945. The property was under the supervision of the Army Ordnance Department. The War Assets Administration accepted custody of the property (3,230 acres) except for the retained area known as the magazine area (2,800 acres) in 1946. The Department of the Army reacquired the 3,230 acres in 1954 and performed cleanup efforts during the 1950s through 1963.
Two property use agreements were entered into by the National Advisory Committee of Aeronautics, the predecessor of NASA, and the Army in 1956 and 1958, respectively. In 1963, accountability and custody of the entire PBOW property (6,030 acres) was transferred to NASA by the Department of the Army. NASA has operated and maintained PBOW since 1963, and it is currently the NASA Glenn Research Center, Plum Brook Station.

Figure 1-2 shows various PBOW areas of concern, including WWTP1 and TNTA. A preliminary investigation of the sewer lines between TNTA and WWTP1 was conducted in 2009. WWTP1 has been investigated separately; an additional investigation of WWTP1 began in December 2008. This SSAP focuses exclusively on the sewer lines from TNTA to WWTP1.

1.2 WWTP1 Sewer Line Description and History

During production in the 1940s, three waste water treatment plants were used to process production waste water from the three TNT manufacturing areas at PBOW. The wastes were accumulated in the settling basins of the TNT manufacturing areas. These wastes were transported to the waste water treatment plants via aboveground and below-ground, wood-stave sewer lines (USACE, 1995). Chemicals in the waste streams included sodium salts of sulfite, sulfate, nitrite, and nitrate; sulfonates of unwanted TNT isomers; trinitrobenzoic acid; trinitrobenzaldehyde; trinitrobenzyl alcohol; nitrotoulenes; and dinitrotoluenes (Dames and Moore, Inc., 1996).

The manufacturing areas were denoted TNT Area A, TNT Area B, and TNT Area C; the waste water treatment plants were denoted Waste Water Treatment Plant No. 1, Waste Water Treatment Plant No. 2, and Waste Water Treatment Plant No. 3. WWTP1 received waste water from TNTA to the east and from TNT Area B to the south. This SSAP includes the sewer lines that extended between TNTA and WWTP1.

The locations of the two sewer lines originally extending from TNTA to WWTP1, approximated from historical as-built maps (Trojan Powder Company, 1944), are shown on Figure 1-3. One line was a 4-inch-diameter line that extends due west from the TNTA settling basins (Building 187) for approximately 2,700 feet before angling southwest to WWTP1. A 1944 drawing indicates that a roughly 500-foot section of this wood-stave line, just west of Taylor Road, is 5 inches in diameter. The other sewer line, 6 inches in diameter, extended directly west-southwest from the TNTA settling basins for approximately 3,800 feet to WWTP1. Wood-stave pipes were constructed of small wood slats (i.e., staves) joined together in a tongue-and-groove fashion and reinforced with steel banding. Use of wood-stave pipes was not uncommon for water and sewage conveyance during the late 1800s until the 1950s.

During PBOW operations, the TNTA sewer lines reportedly often became clogged with TNT residue, and in some instances were completely plugged. The plugged lines were abandoned, and larger diameter bypass sewer lines were constructed around the blocked areas to provide continual drainage of the waste water (USACE, 1995). Information regarding locations of actual plugged lines at PBOW is lacking; however, based on the configuration of the TNTA sewer lines, it is thought that one of the lines may be a replacement line. However, observations made at similar TNT manufacturing facilities from this era reveal that sewer line repairs paralleled the original line and were offset a minimal distance (approximately 20 feet). The large offset between the two lines at TNTA is not consistent with other sewer lines, either at PBOW or other TNT manufacturing facilities.

2.0 Scope of Work and Objectives

2.1 Scope of Work

As specified in the scope of work (USACE, 2010), field activities covered by this SSAP consist of the following tasks:

- Conduct soil trenching.
- Sample soil (using direct-push technology).
- Analyze soil samples.
- Manage and dispose investigation-derived waste (IDW).
- Prepare and submit a geographic information system deliverable.
- Prepare an electronic data deliverable.

The above activities, analytical data, and evaluation will be presented in a site characterization report.

2.2 Objectives

The most recent environmental investigation at PBOW concerning the TNTA/WWTP1 sewer lines was performed in 2008 and 2009. The previous investigation focused on excavation of test pits to determine if appreciable contamination was present. Investigations at similar lines at the West Virginia Ordnance Works found the wooden sewer lines intact and containing up to one pound of TNT per foot of line. It was anticipated that a similar situation might exist at PBOW given the similar operations of the two sites.

Although widely spaced, the test pit excavations did not find any remnants of the sewer line. It was thought at the time that the line may have deteriorated in place, since some oxidized pieces of metal banding were found in test pits. It was later determined the lines were likely removed, although soil contamination was not addressed during the removal Soil contamination was found on the eastern end of the southern line and at one location along the western end of the northern line. The investigation found soil contamination with total nitroaromatic explosives detected at concentrations exceeding 1,000 milligrams per kilogram (mg/kg). In groundwater, total nitroaromatic explosives were detected at up to 70 micrograms per liter. Findings from this initial investigation indicate that soil and groundwater have been impacted. Because of the limited sampling, it is unclear if the sporadic detections represent intermittent leaks or a contiguous line of contamination.

Based on the findings of the investigation, additional data collection is necessary to support development of soil volumes for remediation, if necessary. Additional soil sampling is needed to further define the extent of contamination associated with the former TNTA/WWTP1 sewer lines. Note that the analytical data resulting from this delineation sampling effort will not be used quantitatively in the baseline human health risk assessment or the screening level ecological risk assessment, but these evaluations will rely on the discrete samples collected previously as described in the risk assessment work plans (Shaw, 2010). If appropriate, the delineation sampling data may be referenced qualitatively in the risk assessment reports.

2.3 Site-Specific Data Quality Objectives

2.3.1 Overview

The data quality objectives (DQO) process followed during the project planning stages evaluated data requirements needed to support the decision-making process and select the best action to satisfy these requirements. Incorporated components of the DQO process, described in U.S. Environmental Protection Agency (EPA) Publication 9355.9-01 (EPA, 2006), are discussed in detail in Section 3.3 of the SWSAP. Determining factors for procedures necessary to satisfy investigative objectives and to establish the basis of future actions at PBOW are presented on Figure 2-2 of the SWSAP (Shaw, 2008a).

2.3.2 Data Users and Available Data

A site-specific conceptual model developed using existing data helped to identify data gaps. As described in Section 2.2, the previous investigation found nitroaromatics in soil and groundwater samples collected adjacent to and below the sewer lines. Because the entire sewer line was not sampled, it was difficult to discern whether the detected contamination represented small isolated leaks, spillage during the sewer line removal, or more extensive soil contamination. The field program is designed to provide confirmation of the contamination previously reported and to determine the lateral and vertical extent of the soil contamination.

During the project planning process, effective methodologies for filling the data gaps were designed and reviewed by the data users with the most efficient data collection design implemented to provide the data needed to support any remediation and minimize cost. The main data users are risk assessors and remedial engineers. The SSAP records the rationale for the design, including the location, number, and type of samples necessary to fill the data gaps and to satisfy the DQOs. The SSAP, along with companion documents, provides the regulatory agencies with sufficient detail to conclude whether the investigative effort is adequate to satisfy the study objectives.

2.3.3 Conceptual Site Model

The four factors considered in defining the conceptual model are as follows:

- Potential contaminant sources
- Migration pathways
- Potential human health and ecological receptors
- Types of contaminant of an affected medium.

The source of contamination at the TNTA/WWTP1 sewer lines is from leaks during transfer of liquid wastes from the TNTA area to the WWTP and from potential residual contamination and spillage when the sewer lines were removed. The migration pathways for potential contaminants include leaching to overburden/shale groundwater and bedrock groundwater and runoff to creeks associated with precipitation events. The contaminants of concern are nitroaromatic explosives.

The TNTA/WWTP1 area is currently a maintained grass-covered open field. The assumption for future land use is unrestricted. Plum Brook Station employees and contractors may have casual contact with the soil in the TNTA/WWTP1 area incidental to routine utility servicing or maintenance activities. The possibility of trespassers being exposed to the TNTA/WWTP1 soil is not regarded as plausible because of the security fence and NASA security force. Potential ecological receptors at the TNTA/WWTP1 area are wildlife communities and plant communities. Groundwater in the vicinity of the site is not used as a potable source. Based on an evaluation of existing data, chemicals of concern likely are restricted to nitroaromatic compounds.

2.3.4 Decision-Making Process, Data Uses, and Objectives

The decision-making process that will be followed during the soil delineation activities, as presented in detail in Section 3.3.4 of the SWSAP (Shaw, 2008a), consists of a seven-step DQO process. DQOs are summarized in Table 2-1. The main data users (risk assessors and remedial engineers) will evaluate site risks to both human and ecological receptors and will develop remedial approaches, if necessary. The decision to remediate the soil and/or groundwater is based on the evaluation of the project delivery team, which includes the USACE and Ohio Environmental Protection Agency project managers, with input from the public. The decision-making process is dependent on dissemination of the findings of the investigation and the determination of site risks. This is typically accomplished through reporting, team meetings, and public presentations. The main focus in this investigation is the confirmation of the previous detections and the complete delineation of soil contamination associated with the former sewer line.

2.3.5 Risk-Based Evaluation

Definitive data from samples collected in this effort will be used in combination with existing analytical results and the baseline human health risk assessment currently being prepared to delineate contamination and to support the feasibility study.

2.3.6 Data Quality, Types, and Quantities

Subsurface soil samples will be collected and analyzed to meet the objectives of the delineation activities. Quality assurance/quality control samples will be collected for all sample types described in Chapter 3.0 of this SSAP. All samples will be analyzed by EPA-approved methods and will comply with EPA definitive data requirements. In addition to meeting the quality needs of the delineation activities, data analyzed at this level of quality are appropriate for all phases of the investigation and the feasibility study.

2.3.7 Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity

Laboratory requirements of precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS) for all samples generated during the soil delineation activities are provided in Chapter 3.0 of the QAPP (Shaw, 2008b). Tables 7-1 through 7-5 of the QAPP (Shaw, 2008b) list the laboratory reporting limits (sensitivity). Table 9-1 of the QAPP (Shaw, 2008b) addresses the laboratory requirements and laboratory quality control parameters that affect PARCCS.

3.0 Field Activities

The purpose of soil sampling for this investigation is to define the nature and extent of contamination along the two TNTA/WWTP1 sewer lines. The investigation will be performed using a combination of test pits and direct-push soil sampling. The waste water sewer lines were located from 3 to 5 feet below the ground surface.

No raw explosive material is expected to be encountered during soil sampling activities. The initial investigation found only scattered pieces of wood and metal fragments, suggesting the pipelines may have been removed. Should sampling personnel encounter raw explosives, sampling will stop and Shaw will contact the USACE Nashville District to discuss procedures for disposal of the raw explosive material.

Shaw will obtain all necessary utility clearances and permits from NASA.

3.1 Site Kickoff and Coordination Meeting

A site kickoff and coordination meeting will be held at the project site prior to beginning the investigation. Shaw will present details of the investigation for discussion and coordination (including dig permits and utility clearances) with USACE Nashville District and NASA Plum Brook Station personnel. A portion of the first field day will be occupied by this meeting.

Shaw will provide all portable field office space needed for this field investigation. This will include a portable field trailer, a generator, and necessary office supplies to support the field investigation.

3.2 Soil Sampling

Prior to performing the soil sampling activities, Shaw will locate and mark the locations of the TNTA/WWTP1 sewer lines. The survey marking will conform to the State Plane Coordinate System with centerline stakes placed every 100 feet along each sewer line to aid in locating the sewer line. The areas will then be cleared of vegetation to allow access for test pit excavation and direct-push soil sampling. The vegetative cover currently is maintained grass and will only require mowing.

A qualified geologist or geotechnical engineer will be on site for all drilling and sampling operations. The geologist or geotechnical engineer will be capable of visually classifying and logging all boreholes and test pit material on USACE ENG FORM 5056-R and 5056A-R according to the Unified Soil Classification System, EM 1110-1-4000, and the USACE Nashville District's *HTRW Design Branch Logging Manual*.

A test pit will be excavated every 50 feet along each sewer line and perpendicular to it for purposes of accurately locating the line. The location of the test pits will be at the surveyed locations described above (100-foot spacing) and at midpoints between these surveyed locations. This approach will allow for the demarcation of the sewer lines in 50-foot sections. After the sewer line is located and marked, composite soil samples will be collected along each 50-foot section using direct-push sampling methods, focusing on the zone immediately below the former sewer line. Each composite sample will consist of five aliquots. The proposed test pit locations are shown on Figure 3-1, and the proposed test pit and boring location layout is shown on Figure 3-2.

The composite samples collected from along the sewer line will be field screened using colorimetric test kits to determine the explosive content. The colorometric test kits provide semiquantitative results up to a concentration of approximately 85 mg/kg based on previous use at the PBOW site. To evaluate the accuracy of the field screening data, approximately 35 specialized confirmation samples (a number equal to approximately 10 percent of the total number of screening samples) will be collected to evaluate the efficacy of the screening samples and to identify nitroaromatic contaminants immediately along the sewer line. These "verification of screening" samples will be submitted for fixed-base laboratory analysis for nitroaromatics on a quick turnaround basis (e.g., 72 hours). It is anticipated that the "verification of screening" samples submitted will encompass the full range of nitroaromatic detections (low [less than 10 mg/kg], medium [10 to approximately 85 mg/kg] and high [more than approximately 85 mg/kg] concentrations) as well as nondetect results. The data comparison will be completed immediately upon data receipt to allow for adjustments in the field screening approach should deficiencies be identified. The data evaluation will be completed in conjunction with USACE.

The results of the field screening will be used to determine the locations from which the additional confirmation samples will be submitted for laboratory analysis for nitroaromatics. These additional confirmation samples (i.e., other than the "verification of screening" samples) will comprise approximately 260 samples that exceed a low-end concentration criterion based on the screening results. Initially, a criterion of 10 mg/kg total nitroaromatics (field screening) will be considered as this low-end criterion for collecting confirmation samples. The main limitation of the field screening is that it provides only semiquantitative results. For example, field screening provides an estimated concentration for 2,4,6-TNT as well as other nitroaromatics (1,3,5-trinitrobenzene, etc.) and total DNT. Given the different toxicities for the various nitroaromatics, the low-end screening concentration criterion for selecting confirmation sample locations may need to be adjusted (from 10 mg/kg) based on the evaluation of the field screening data discussed in the previous paragraph.

At the locations where composite samples exceed 10 mg/kg (or adjusted value) total nitroaromatics, three discrete subsurface samples from 8 to 10 feet below ground surface will be collected. In addition, to delineate the lateral extent of contamination, composite samples will be collected approximately 10 feet on either side of the sewer line location. Should these samples exceed 10 mg/kg, additional samples will be collected laterally until the screening results are less than 10 mg/kg total nitroaromatics. These lateral step-outs are anticipated to be at approximately 10-foot intervals, but the step-out distance may be adjusted in the field based on sampling results. Once the screening analysis indicates the contamination is less than 10 mg/kg in a step-out sample, a confirmation sample from that location will be submitted to the laboratory for analysis.

It is assumed that up to 350 soil screening samples and 295 confirmation samples will be collected for laboratory analysis (Table 3-1). This assumes approximately 36 composite samples along the sewer line trace will exhibit nitroaromatics concentrations in excess of 10 mg/kg. The discrepancy between the total number of field screening samples and confirmation samples is based on the assumption that some field screening samples for lateral delineation will have concentrations of nitroaromatics exceeding 10 mg/kg; these samples will not be sent off for confirmation analysis.

Open excavations and boreholes will be backfilled at the end of each day. Test pits will be backfilled with the excavated soils and compacted with excavation equipment tracking methods. Following collection of the soil samples, the direct-push boreholes will be backfilled with granular bentonite.

Nitroaromatics will be analyzed in every sample that is shipped to the laboratory.

3.2.1 Sample Location Sketch Maps

The intent of the location sketch map, beyond giving a general location for each sample, is to give enough information that the test pit and boring locations may be revisited with the log alone. To aid in this purpose and for better field orientation, critical reference points or landmarks will be included in the sketches. In locations which lack any landmarks to reference, any available information will be included, such as distance along the line based on test pit locations and hand-held global positioning system readings.

3.2.2 Soil Classification

Each location selected for test pits will receive a visual geotechnical classification of the material to the extent practical. This will include collection of grab samples from the excavator to aid in soil descriptions. Shaw will also provide cross-section sketches of the sewer line trench to show the delineation between the trench materials and surrounding native soils.

Borings for soil sample collection will be logged continuously for the entire boring from ground surface to bottom of hole for visual geotechnical classification. The geologist or geotechnical engineer will visually classify and log all boreholes and test pits on USACE ENG FORM 5056-R and 5056A-R according to the Unified Soil Classification System, EM 1110-1-4000, and the USACE Nashville District's *HTRW Design Branch Logging Manual*.

3.3 Land Survey

Shaw will establish coordinates and elevations according to EM 1110-1-4000 for the waste water sewer line, the soil boring, and test pits. The coordinates will be to the closest 1 foot and referenced to the State Plane Coordinate System. Elevations will be surveyed to within ± 0.01 feet referenced to the National Geodetic Vertical Datum of 1929.

3.4 Utility Clearances

Prior to beginning any intrusive investigation (i.e., excavation, soil boring), to fulfill Shaw standard operating procedures and USACE requirements, all sites will be marked for underground utilities by personnel from NASA, Plum Brook Station Health and Safety Division, or other appropriate department.

3.5 Site Access

All Shaw personnel and subcontractors will meet each morning at the NASA Plum Brook Station to attend the morning tailgate safety meeting, calibrate equipment, gather needed material, and replenish water. Therefore, all Shaw personnel and any subcontracted personnel involved must be U.S. citizens. Names of Shaw personnel and Shaw subcontractors will be provided by Shaw to Mr. Robert Lallier, NASA Environmental Coordinator, at least 72 hours in advance so that site access can be arranged. All personnel entering the site will be appropriately trained and instructed by Plum Brook Station concerning site safety issues.

3.6 Site Restoration

Upon completion of site activities, all sites will be regraded and, to the extent practical, restored to their original condition. Discussions with the RAB indicated that reseeding would not be necessary along the sewer line, as the site will naturally reseed in native grasses. Removal of mature trees will not be required at this site, only the removal of brush and young successional tree plots which have a naturally high regeneration rate.

4.0 Sample Analysis and Decontamination Procedures

4.1 Sample Number System

Sample numbering system to be used during this investigation will conform to the USACE Nashville District's numbering convention. Specifically, each sample will be assigned a unique sample identification number that describes where the sample was collected. Each number consists of a group of letters and numbers, separated by hyphens. The sample media and numbering system are described as follows.

Project Code	Year	Sample Type[a]	Site Identification[b]	Location (Well ID)	Sample Number	Depth[c]
PBOW	10	XX	XXXX	XXXX	XXXX	(XXXX)

[a] Sample type:
SS – surface soil sample
SB – subsurface soil sample
GW – groundwater sample
MS – matrix spike
MD – matrix spike duplicate

[b] Site:

WWSL1 – Waste Water Treatment Plant 1 sewer lines (note that the acronym is changed from that which appears in the rest of this SSAP to avoid possible confusion of the samples with those collected for Waste Water Treatment Plant 1, which is being investigated separately.)

[c] Depth: Only required for soil samples.

The complete sample number will be recorded by the Shaw field geologist/geotechnical engineer in the field activity daily log and/or in the boring log, and in the sample collection log as appropriate.

4.2 Analytical Program

Field screening analysis will conform to EPA Method 8515. A DOD Environmental Laboratory Accreditation Program-accredited laboratory will analyze confirmation samples for nitroaromatics by EPA Method SW-846 8330. All applicable analyses will meet the recommended method guidance found in *Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods*, SW-846, Third Edition, Update III (EPA, 1996) and its subsequent updates. They will meet the quality assurance/quality control requirements outlined in EM-200-

1-6, *Chemical Quality Assurance for Hazardous, Toxic and Radioactive Waste (HTRW) Projects* (USACE, 1997). The analytical laboratory must comply with *Quality Systems Manual for Environmental Laboratories*, Final Version 4.1 (DOD, 2009). All other requested analyses must conform to their specified method(s).

4.3 Decontamination Procedures

Decontamination requirements and procedures are specified in detail in Chapter 5.0 of the SWSAP (Shaw, 2008a) and will be followed during the current investigation. The Shaw field coordinator must contact Plum Brook Station for access to a potable water source to use for decontamination. The following decontamination procedures for equipment will be performed before site entry, between borings, and before site departure:

- Nonsampling equipment (direct-push rods, augers, drill rods, etc., that does not contact analytical samples):
  - Steam rinse with potable water, or wash and scrub using a brush with nonphosphate detergent and then rinse with potable water.
- Equipment that may come in contact with samples for chemical analysis (stainless-steel homogenization bowls, mixing spoons, drill bit shoes, drill sleeves, etc.):
  - Remove excess soil from equipment and containerize or return to excavation/boring
  - Prewash using a brush and potable water (no detergent)
  - Wash and scrub using a brush with nonphosphate detergent.
  - Rinse with potable water.
  - Rinse with American Society for Testing and Materials (ASTM) Type II water.
  - Rinse with reagent-grade isopropanol.
  - Rinse with ASTM Type II water.
  - Air dry.
  - Wrap in aluminum foil.

Decontamination wash water and rinse water will be managed for disposal as described in Section 6.0.

5.0 Sample Preservation, Packing, and Shipping

Sample containers and caps will be new, certified as precleaned, and made of materials recommended by the EPA in Title 40, Code of Federal Regulations, Part 136 and SW-846 (EPA, 1996). Sample containers and preservatives/preservation methods are summarized in Table 5-1. Sample containers will be supplied and shipped to the job site by the designated primary laboratory.

Each sample container will be bagged before placement in the cooler. Sample holding times will be based on the date and time of sample collection.

Samples for chemical analysis will be placed in coolers as soon as possible after collection and will be packed to minimize container breakage by using styrofoam peanuts or bubble wrap to fill void spaces in the cooler. Vermiculite will not be used for sample packing material. Coolers will be taped, marked, and sealed. Custody will be maintained, as described in Chapter 6.0 of the SWSAP. Samples will be cooled to a temperature within 0 to 6 degrees Celsius and maintained at that temperature by means of double-bagged ice until the cooler is received at the laboratory. Coolers will be shipped to the laboratory by a next-day delivery service. The temperature of each cooler will be taken with an infrared thermometer upon receipt. Notification of shipment, including airbill number, will be telephoned or faxed to the laboratory on the day sample shipment is initiated. If this is not possible, the laboratory will be notified the following morning.

Completed analytical request/chain-of-custody records will be secured and included with each shipment of coolers to:

Primary Laboratory
ATTN: Sue Bell
Accutest Laboratories
4405 Vineland Road
Orlando, Florida 32811
P: 813-741-3338
F: 813-741-9137
C: 813-992-0090
SueB@accutest.com

QA Laboratory
ATTN: Denise Pohl
Test America
4101 Shuffel Drive NW
North Canton, Ohio 44720
P: 330-966-9789
F: 330-497-0772
denise.pohl@testamericainc.com

6.0 Investigation-Derived Waste Management Plan

Anticipated IDW during field activities includes soil (drill cuttings), decontamination fluid, and disposable personal protective equipment (PPE). Detailed procedures for IDW management are provided in Chapter 8.0 of the SWSAP (Shaw, 2008a). The following is a brief summary of the procedures for handling IDW.

6.1 Soil

Residual subsurface soil will be placed in 55-gallon drums upon completion of field sampling. IDW drums will be labeled to indicate project name and date collected.

6.2 Decontamination Fluid

Limited quantities of decontamination fluid, including wash water, nonphosphate soapy water, and final rinse water, will be kept in plastic tubs during the decontamination process and will be placed in 55-gallon drums upon completion of field sampling. Decontamination fluid containing small quantities of solvents such as isopropanol, methanol, and hexane will be collected in metal pans for evaporation.

6.3 Sampling Equipment and Personal Protective Equipment

Limited quantities of PPE and sampling equipment will be generated during sampling activities, including Tyvek® suits, latex or nitrile gloves, and plastic sheeting. All sampling equipment and PPE will be double-bagged and disposed of in on-site Shaw dumpsters. If any of the sampling equipment and PPE appears to be grossly contaminated, it will be decontaminated prior to disposal.

6.4 Investigation-Derived Waste Sampling

All soil and water IDW will be sampled at the completion of fieldwork. Table 5-1 summarizes the analytical parameters and methods for the IDW samples. For collection of IDW composite soil samples, a portion of the composite sample for each section will be collected and placed in a resealable plastic bag. One composite IDW sample will be collected from each of the resealable plastic bags at the completion of the drilling activity.

For collection of the IDW composite water sample, a 2-inch bailer will be used to collect multiple samples from the 55-gallon drums used to store decontamination water. One composite sample per medium will provide representative analytical results to safely represent the media being sampled and satisfy the landfill analytical acceptance requirements. If the number of proposed borings increases, the number of composite samples may also be increased to adequately represent the media being sampled.

The composite samples will then be submitted to the identified laboratory for a full toxicity characteristic leaching procedure analysis and nitroaromatics analysis. A seven-day turnaround time will be used for all IDW samples unless otherwise directed by the project manager. Composite samples of decontamination water from the excavation and direct-push sampling will be collected and submitted for target compound list volatile organic compounds, target compound list semivolatile organic compounds, target analyte list metals, nitroaromatics, and pH.

When the analytical results are received, Shaw personnel will evaluate the results and determine off-site disposal methods. Shaw will identify possible disposal facilities; however, USACE is responsible for selecting the facility or facilities to receive the IDW.

7.0 References

Dames and Moore, Inc., 1996, ***Site-Wide Groundwater Investigation Draft Report, Plum Brook Ordnance Works, Sandusky, Ohio***, May.

Shaw Environmental, Inc. (Shaw), 2010, ***Work Plans, Baseline Human Health Risk Assessment and Screening Level Ecological Risk Assessment, TNT Area A and TNT Area B to to Waste Water Treatment Plant 1 Sewer Lines, Plum Brook Ordnance Works, Sandusky, Ohio***, February.

Shaw Environmental, Inc. (Shaw), 2008a, ***Site-Wide Sampling and Analysis Plan, Plum Brook Ordnance Works, Sandusky, Ohio***, July.

Shaw Environmental, Inc. (Shaw), 2008b, ***Site-Wide Quality Assurance Project Plan, Plum Brook Ordnance Works, Sandusky, Ohio***, July.

Shaw Environmental, Inc. (Shaw), 2008c, ***Site-Wide Health and Safety Plan, Plum Brook Ordnance Works, Sandusky, Ohio***, July.

Trojan Powder Company, 1944, ***Proposed New Elevation for Existing 4 In. Round Wood Flume Pipe Line, T.N.T. Area "A" to Disposal Plant***, Drawing No. 1670-T-505-4, January 28.

U.S. Army Corps of Engineers (USACE), 2010, ***Scope of Work, Delineation of Soil Contamination Along the Sewer Lines Between TNT Area A and Waste Water Treatment Plant 1, Former Plum Brook Ordnance Works, Sandusky, Ohio***, June 21.

U.S. Army Corps of Engineers (USACE), 1997, ***Chemical Quality Assurance for Hazardous, Toxic and Radioactive Waste (HTRW) Projects***, EM 200-1-6, October 1997.

U.S. Army Corps of Engineers (USACE), 1995, ***Site Management Plan, Plum Brook Ordnance Works, Sandusky, Ohio, Part B, Areas of Concern***, September.

U.S. Department of Defense (DOD), 2009, ***Quality Systems Manual for Environmental Laboratories***, Final Version 4.1, April.

U.S. Environmental Protection Agency (EPA), 2006, ***Guidance on Systematic Planning Using the Data Quality Objectives Process***, EPA 240-B-06-001, Office of Environmental Information, Washington, D.C., February

U.S. Environmental Protection Agency (EPA), 1996, ***Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods***, EPA Publications SW-0846, Third Edition, Update III, (http://www.epa.gov/sw-846/sw846.htm).

TABLES

Table 2-1

Summary of Data Quality Objectives
TNTA to WWTP1 Sewer Line
Subsurface Soil Sampling
Former Plum Brook Ordnance Works, Sandusky, Ohio

Potential Data Users	Available Data	Conceptual Model	Media of Concern	Data Uses and Objectives	Data Types	Analytical Level
EPA OEPA DOD USACE NASA Shaw Other Contractors Possible Future Land Users	Previous environmental investigations show varying degrees of contamination in the groundwater and soil.	Contaminant Source Leaks from waste water sewer lines generated from the production of TNT Residual waste from removal of TNTA sewer lines Migration Pathways Soil and groundwater Potential receptors Human Potential Contaminants of Concern Nitroaromatic explosives	Soil	Determine if there are hazardous substances present that constitute an unacceptable risk to human health and the environment. Define site physical features and characteristics. Evaluate fate and transport pathways Determine the nature and extent of source areas. Define current and future routes of exposure. Determine whether contaminant distribution is consistent with DOD activities	Soil Explosives	Field screen Laboratory screen Definitive Definitive

DOD - U.S. Department of Defense.
EPA - U.S. Environmental Protection Agency.
OEPA - Ohio Environmental Protection Agency.
USACE - U.S. Army Corps of Engineers

NASA - National Aeronautics and Space Administration.
TNT - Trinitrotoluene.
TNTA - TNT Area A.
Shaw - Shaw Environmental, Inc.
WWTP1 - Waste Water Treatment Plant 1.

Table 3-1

Summary of Soil Samples to be Collected
TNTA to WWTP1 Sewer Lines
Former Plum Brook Ordnance Works, Sandusky, Ohio

Parameters	Field Samples	QA/QC Duplicate Samples [a]	Rinsates	Source Water	Matrix Spike/MS Duplicate [b]	Totals
Field Screen Nitroaromatics	350	0	0	0	0/0	350
Nitroaromatics	295	30/30	0	1	15/15	387

[a] QC samples are blind duplicates sent with originals, QA samples sent to QA laboratory.
[b] One matrix spike/matrix spike duplicate will be analyzed for each batch of 20 samples.

QA - Quality assurance.
QC - Quality control.
TNTA - TNT Area A.
WWTP1 - Waste Water Treatment Plant 1.

Table 5-1

Analytical Methods, Containers, Preservatives, and Holding Times
TNTA to WWTP1 Sewer Lines
Former Plum Brook Ordnance Works, Sandusky, Ohio

Matrix	Parameter	Analytical Method	Sample Container [b]	Preservation Requirements	Holding Time
Soil [a]	Nitroaromatics	SW-846 8330	(1) 4 oz CWM glass with Teflon-lined lid	Cool to 4^{o}C	14 days extraction/40 days
Liquid IDW	TCL VOCs	SW-846 5030B/8260B	(3) 40 ml VOA vial	Cool to 4$\underline{+}$2^{o}C, HCL to pH <2	14 days
	TCL SVOCs	SW-846 3510C/8270C	(2) 1 L amber glass	Cool to 4$\underline{+}$2^{o}C	7 days extraction/40 days
	TAL Metals	SW-846 3005A/6010B/7470A	(1) 250 mL HDPE	Cool to 4$\underline{+}$2^{o}C, HNO_3 to pH <2	6 months (28 days for Hg)
	Nitroaromatics	SW-846 8330	(1) 1 L amber glass	Cool to 4$\underline{+}$2^{o}C	7 days extraction/40 days
	pH	SW-846 9045B	(1) 250 mL HDPE	Cool to 4$\underline{+}$2^{o}C	ASAP
Solid IDW	TCLP VOCs	SW-846 1311/5030B/8260B	(1) 8 oz CWM glass with Teflon-lined lid	Cool to 4$\underline{+}$2^{o}C	14 days extraction and analysis
	TCLP SVOCs	SW-846 1311/3510C/8270C			14 days extraction/40 days
	TCLP Metals	SW-846 1311/3005A/6010B/7470A			14 days /ext./6 months (28 days for Hg)
	Nitroaromatics	SW-846 8330	(1) 4 oz CWM glass with Teflon-lined lid		14 days extraction/40 days

^{o}C - Degrees Celsius.
CWM - Clear wide mouth.
HCI - Hydrochloric acid.
Hg - Mercury.
HNO_3 - Nitric acid.
L - Liter.
mL - Milliliter.
oz - Ounces.
Ext. - Extraction

SVOC - Semivolatile organic compound.
TAL - Target analyte list.
TCL - Target compound list.
VOC - Volatile organic compound.
IDW - Investigative-derived waste.
EPA - U.S. Environmental Protection Agency.
VOA - Volatile organic analysis.
ASAP - As soon as possible.
TNTA - TNT Area A.
WWTP1 - Waste Water Treatment Plant 1.

[a] Multi-incremental sampling will not be used.
[b] Number of containers required in ( ).

FIGURES

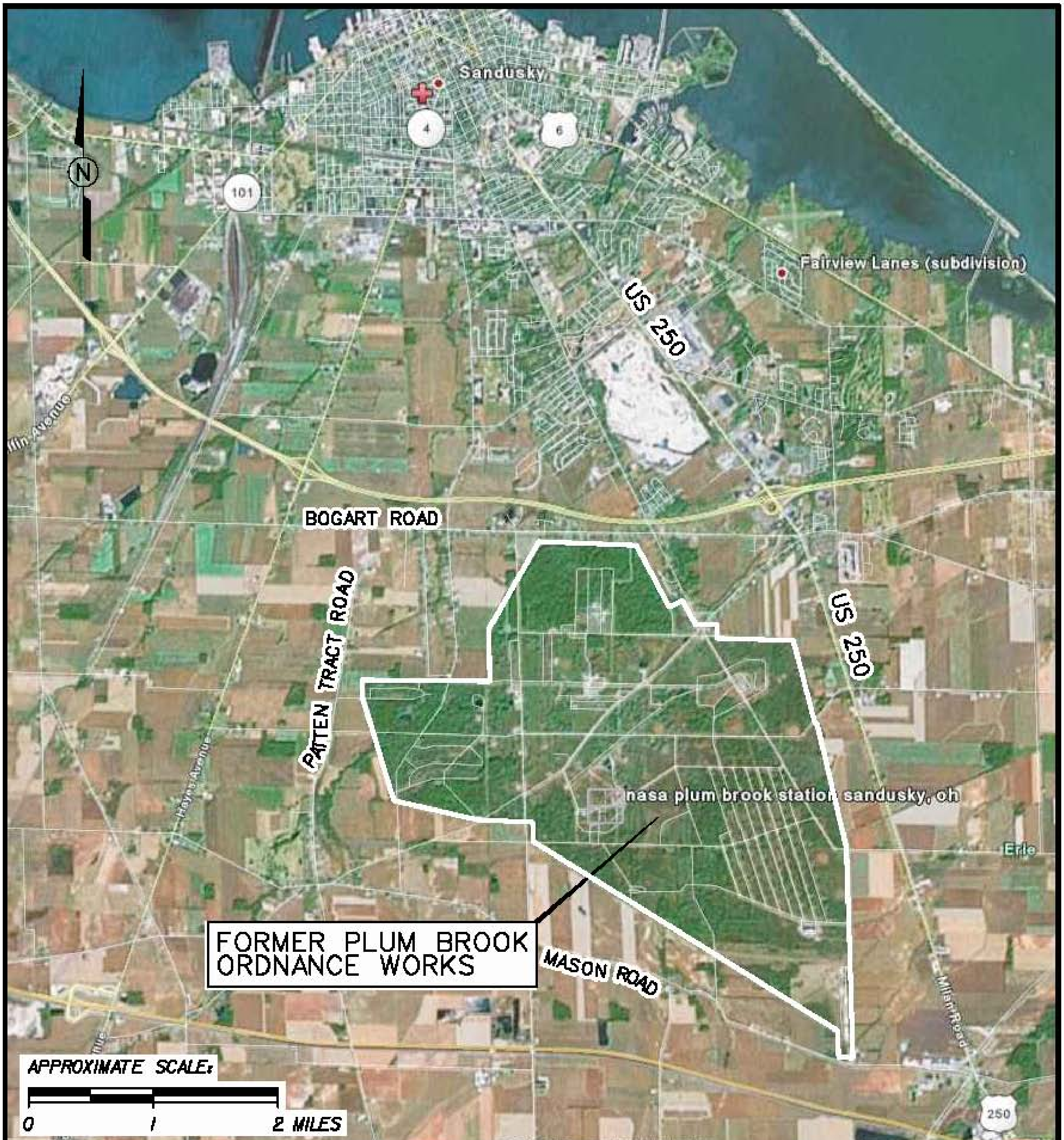
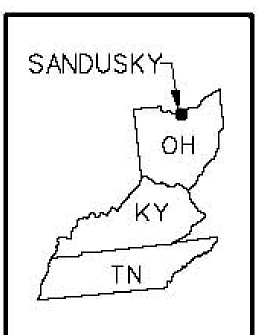


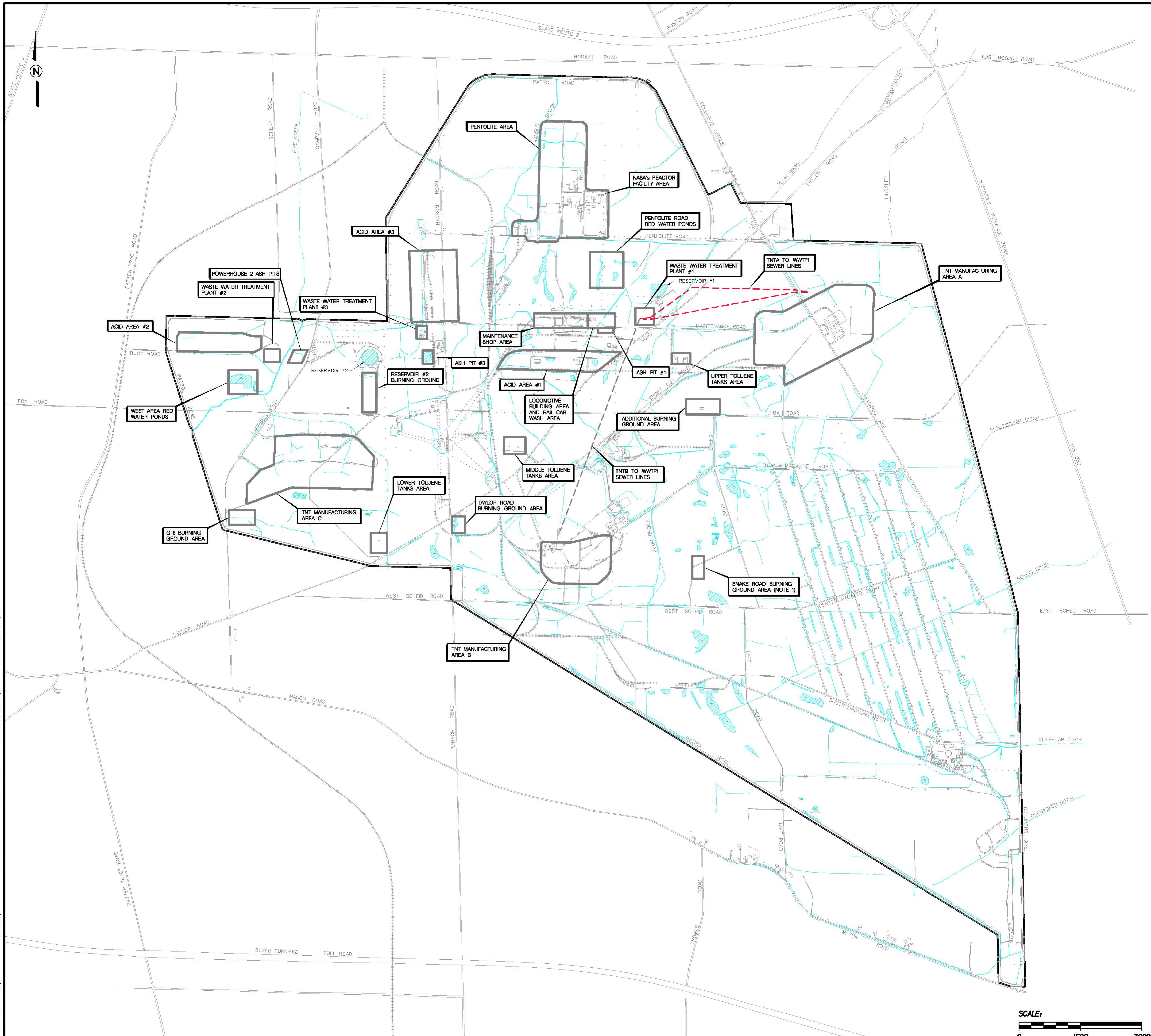
FIGURE 1-1
PBOW VICINITY MAP



TNTA TO WWTP1 SEWER LINES SSAP
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw® a world of **Solutions**™

139798_ssap_001.dgn cbentley 10/14/2010 3:39:29 PM PDF_with_Levels.plt SEI_textsub_only.tbl



LEGEND:

- APPROXIMATE LOCATION OF TNTA TO WWTP1 SEWER LINES
- POND
- CREEK, DITCH, CONVEYANCE
- RAILROAD
- ROAD
- FENCE
- FACILITY BOUNDARY

NOTES:

1. SNAKE ROAD BURNING GROUND AREA WAS ALSO REFERRED TO AS "SNAKE ROAD BURN PIT", "SCHEID ROAD BURNING GROUNDS", AND "DISPOSAL AREA THREE".
2. REACTOR FACILITY CONSTRUCTED BY NASA POST WWII AND IS IDENTIFIED FOR LOCATION PURPOSES ONLY.

FIGURE 1-2
LOCATION OF TNTA TO WWTP1 SEWER LINES AT PBOW

TNTA TO WWTP1 SEWER LINES SSAP
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

SCALE: 0 1500 3000 FEET

Shaw a world of Solutions™

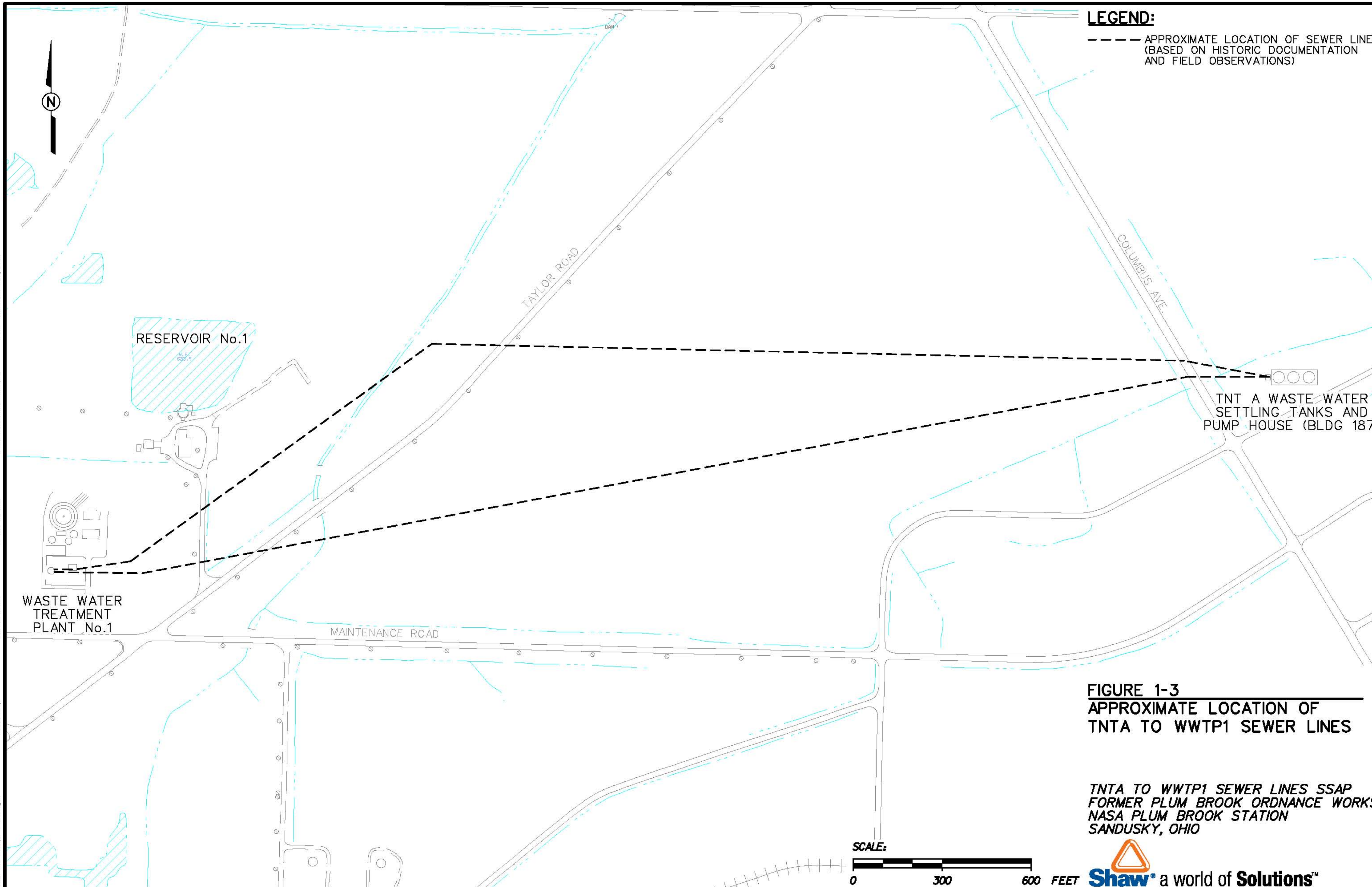
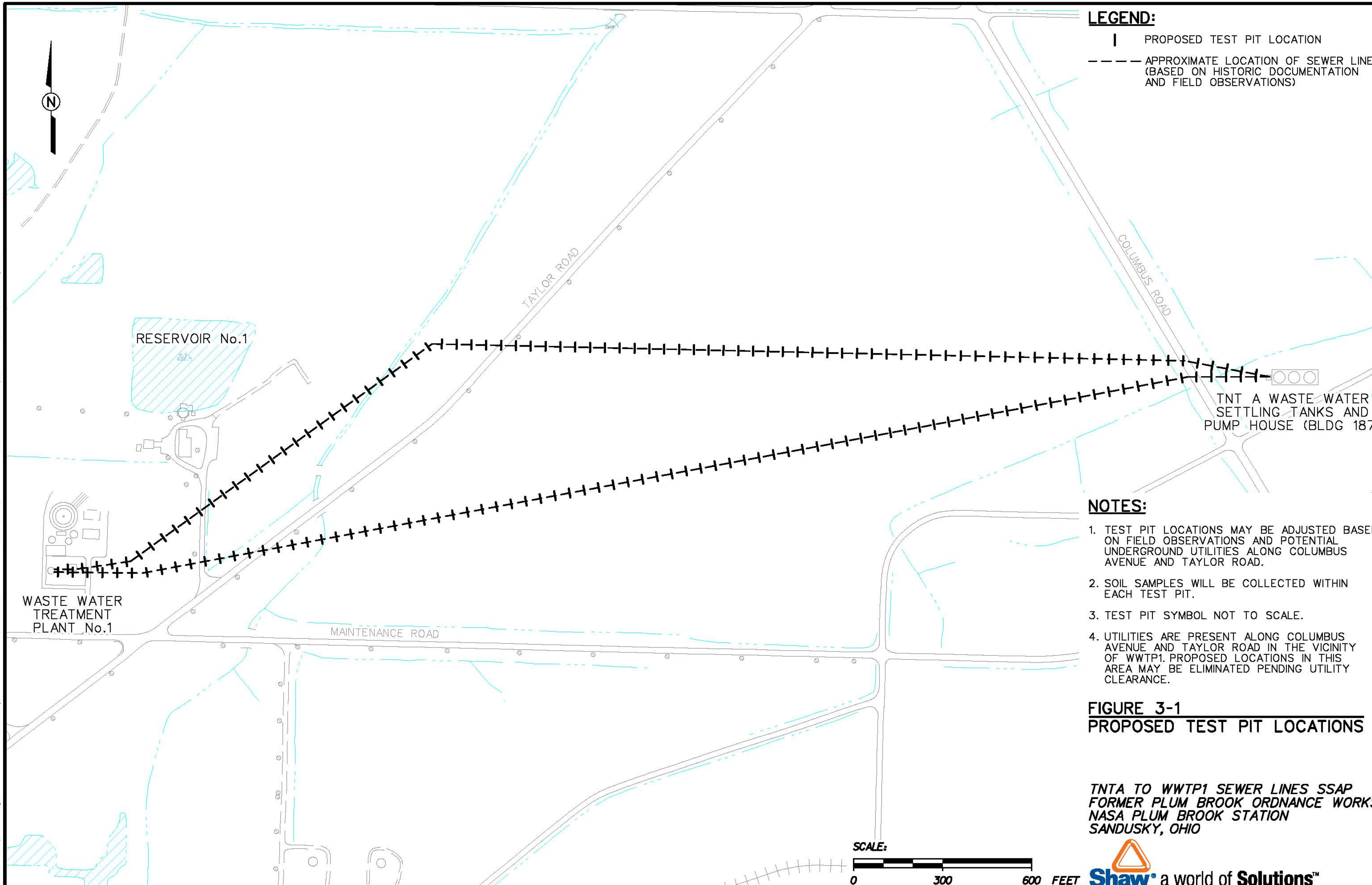


FIGURE 1-3
APPROXIMATE LOCATION OF TNTA TO WWTP1 SEWER LINES

TNTA TO WWTP1 SEWER LINES SSAP
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO



LEGEND:

ǀ	PROPOSED TEST PIT LOCATION
– – – –	APPROXIMATE LOCATION OF SEWER LINES (BASED ON HISTORIC DOCUMENTATION AND FIELD OBSERVATIONS)

NOTES:

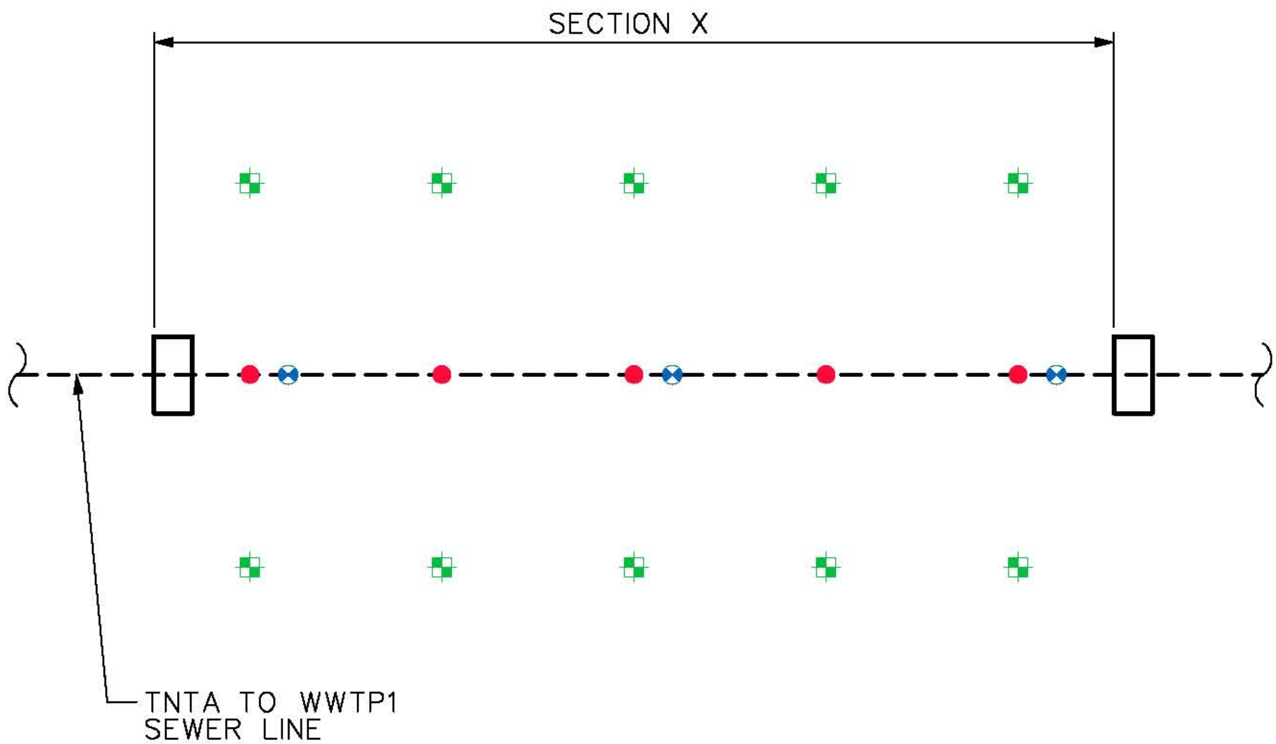
1. TEST PIT LOCATIONS MAY BE ADJUSTED BASED ON FIELD OBSERVATIONS AND POTENTIAL UNDERGROUND UTILITIES ALONG COLUMBUS AVENUE AND TAYLOR ROAD.
2. SOIL SAMPLES WILL BE COLLECTED WITHIN EACH TEST PIT.
3. TEST PIT SYMBOL NOT TO SCALE.
4. UTILITIES ARE PRESENT ALONG COLUMBUS AVENUE AND TAYLOR ROAD IN THE VICINITY OF WWTP1. PROPOSED LOCATIONS IN THIS AREA MAY BE ELIMINATED PENDING UTILITY CLEARANCE.

FIGURE 3-1
PROPOSED TEST PIT LOCATIONS

TNTA TO WWTP1 SEWER LINES SSAP
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw® a world of Solutions™

139798_ssap_004.dgn cbentley 10/15/2010 8:37:01 AM PDF_with_Levels.plt SEL_textsub_only.tbl



SCALE:

0 10 20 FEET

LEGEND:

- TEST PIT
- INITIAL BORING LOCATIONS FOR FIELD SCREENING COMPOSITE
- OFFSET BORING LOCATIONS FOR LATERAL DELINEATION FIELD SCREENING COMPOSITES
- BORING LOCATIONS FOR LABORATORY CONFIRMATION SAMPLES

FIGURE 3-2
PROPOSED TEST PIT AND BORING LOCATION LAYOUT

TNTA TO WWTP1 SEWER LINES SSAP
FORMER PLUM BROOK ORDNANCE WORKS
NASA PLUM BROOK STATION
SANDUSKY, OHIO

Shaw® a world of **Solutions**™